

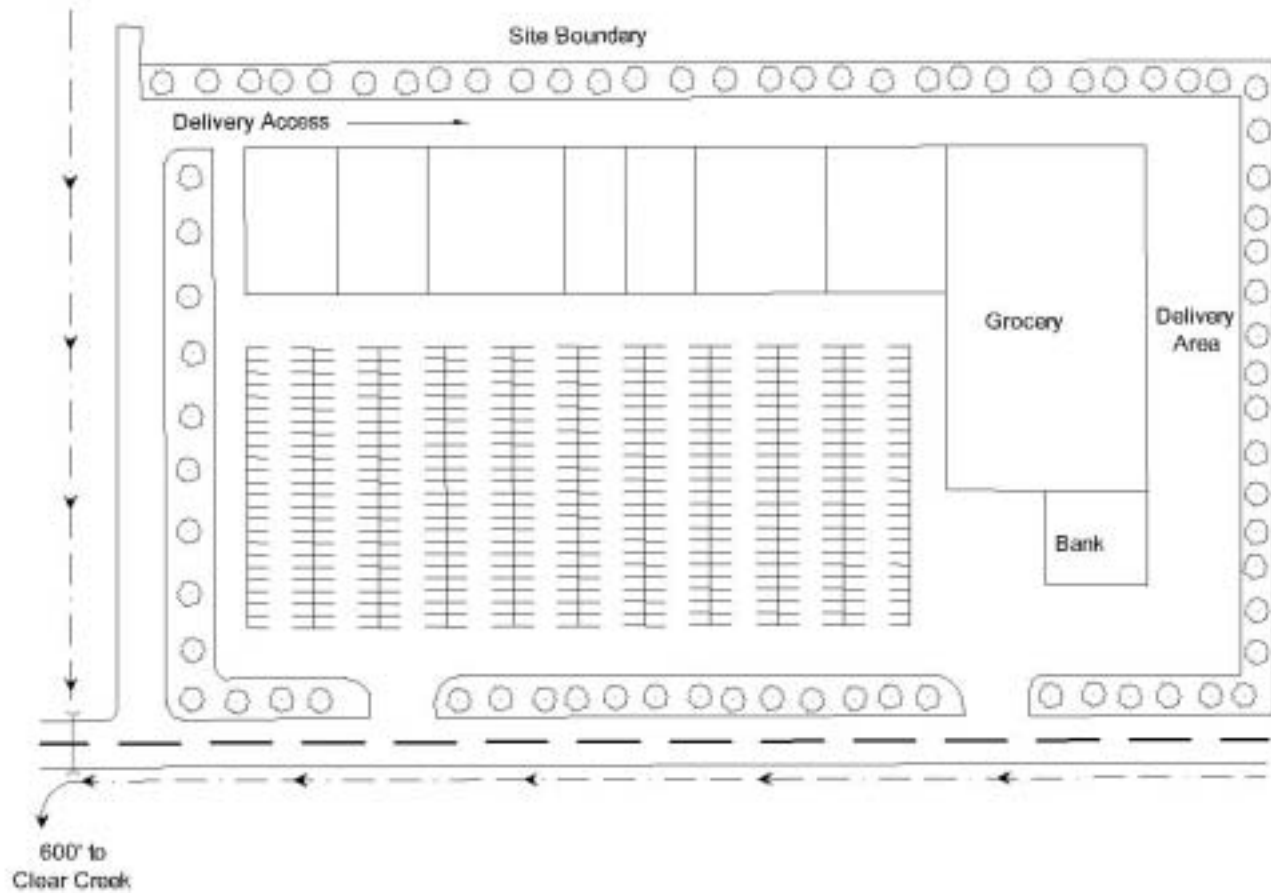
# Redevelopment (Commercial Site)



# Redevelopment (Commercial)

- Pre 1970's strip mall, with no stormwater protection to speak of
- Converting to gas station/convenience store plus various other stores
- Existing collection along streets to identified drainage channel





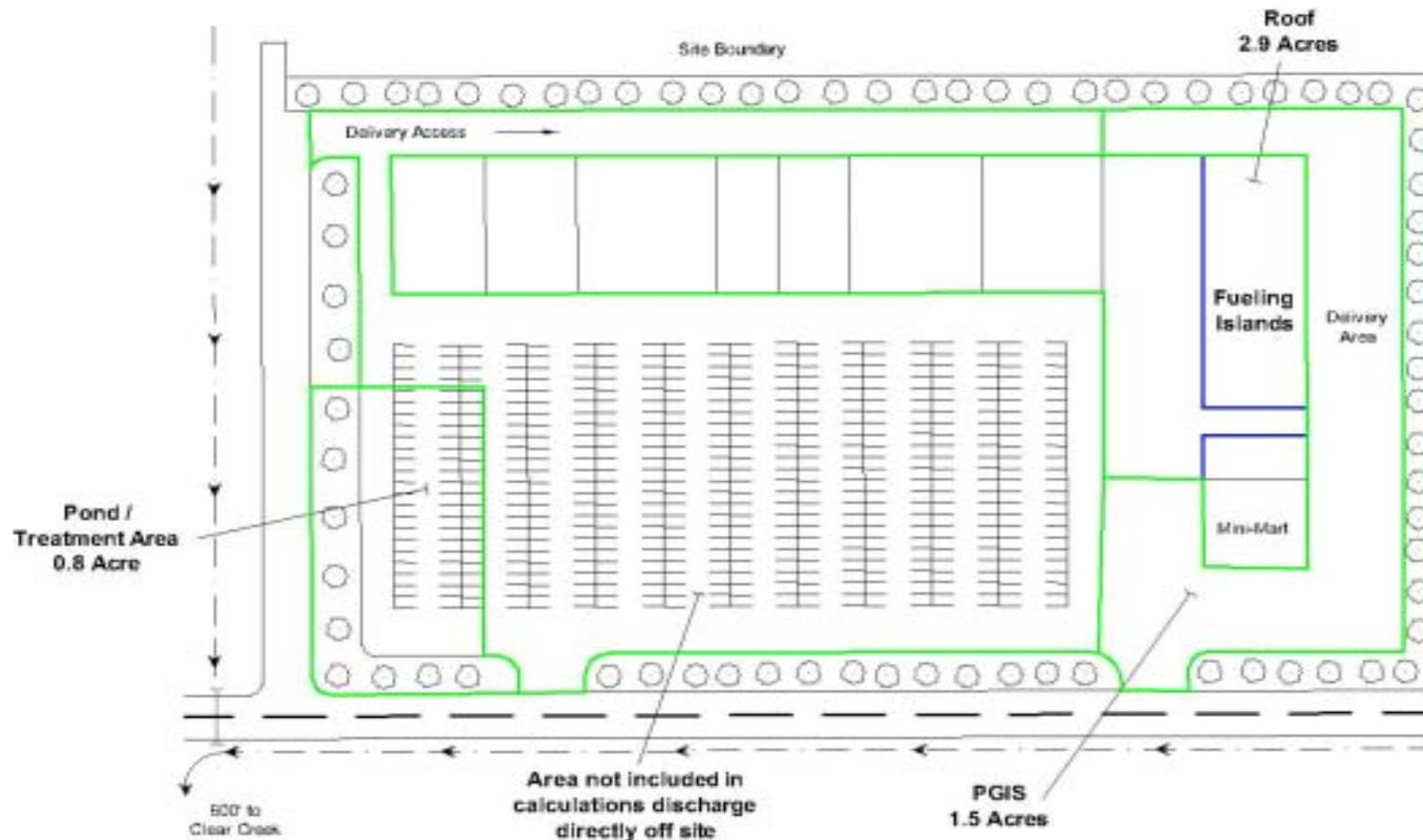
**Commercial Redevelopment**  
Existing Site Conditions



# Stormwater Site Plan

- Won't repeat here but need to complete
  - Step 1: Existing Conditions (Section 3.1.1)
  - Step 2: Preliminary Development Layout (Section 3.1.2)
  - Step 3: Offsite analysis (Section 3.1.3)





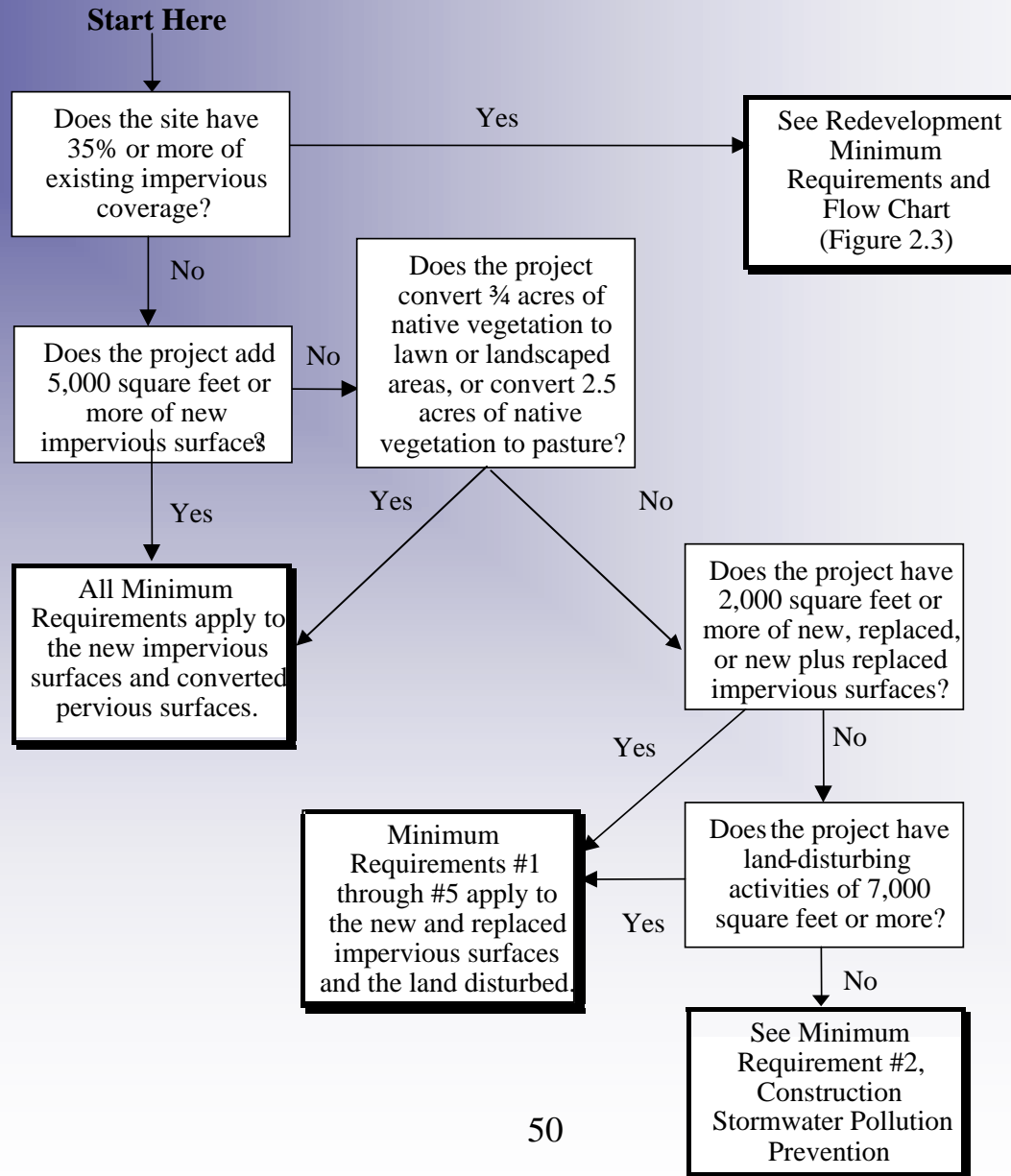
**Commercial Redevelopment**  
Proposed Site Improvements



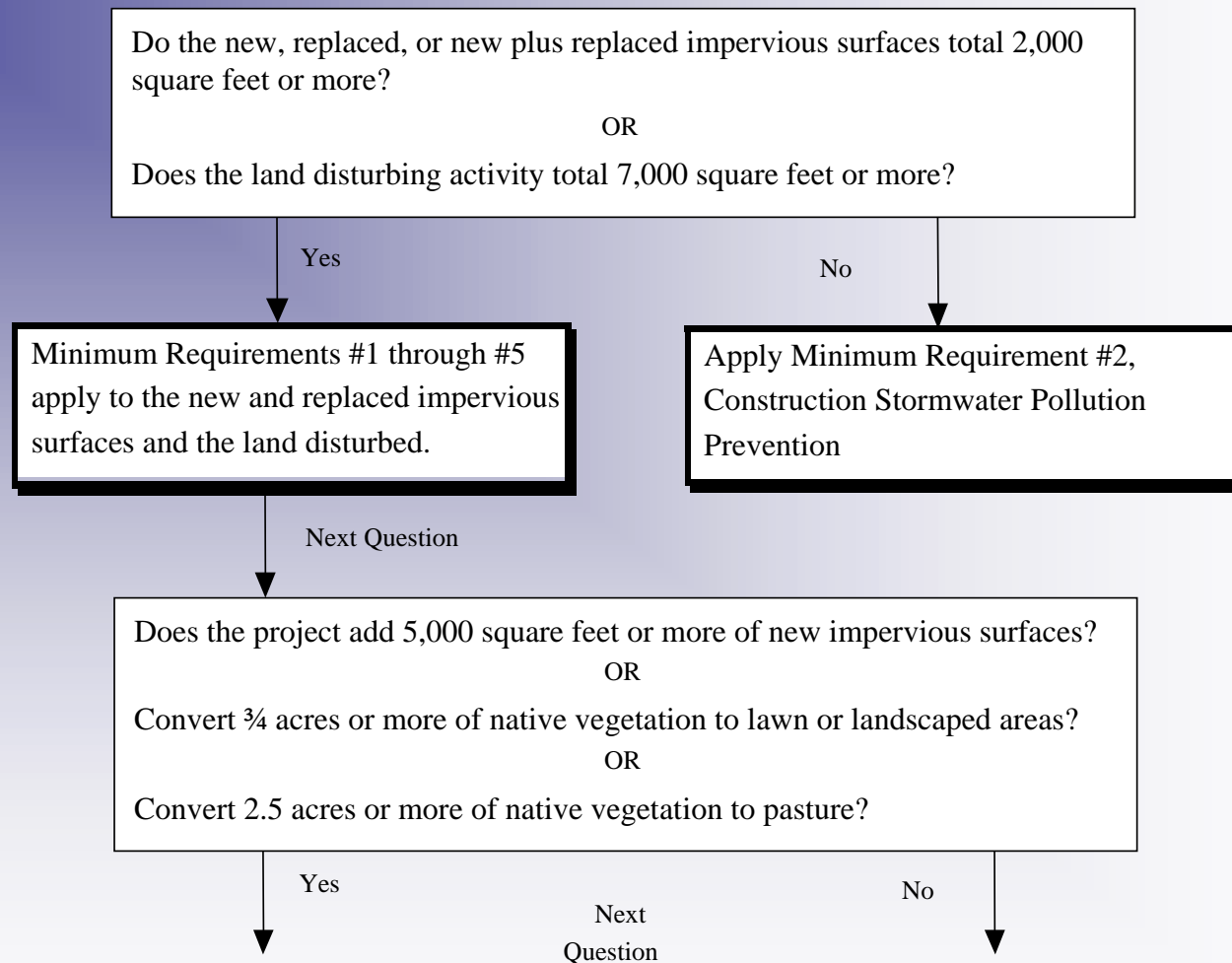
# Step 4: Determine Applicable Minimum Requirements (Section 3.1.4)



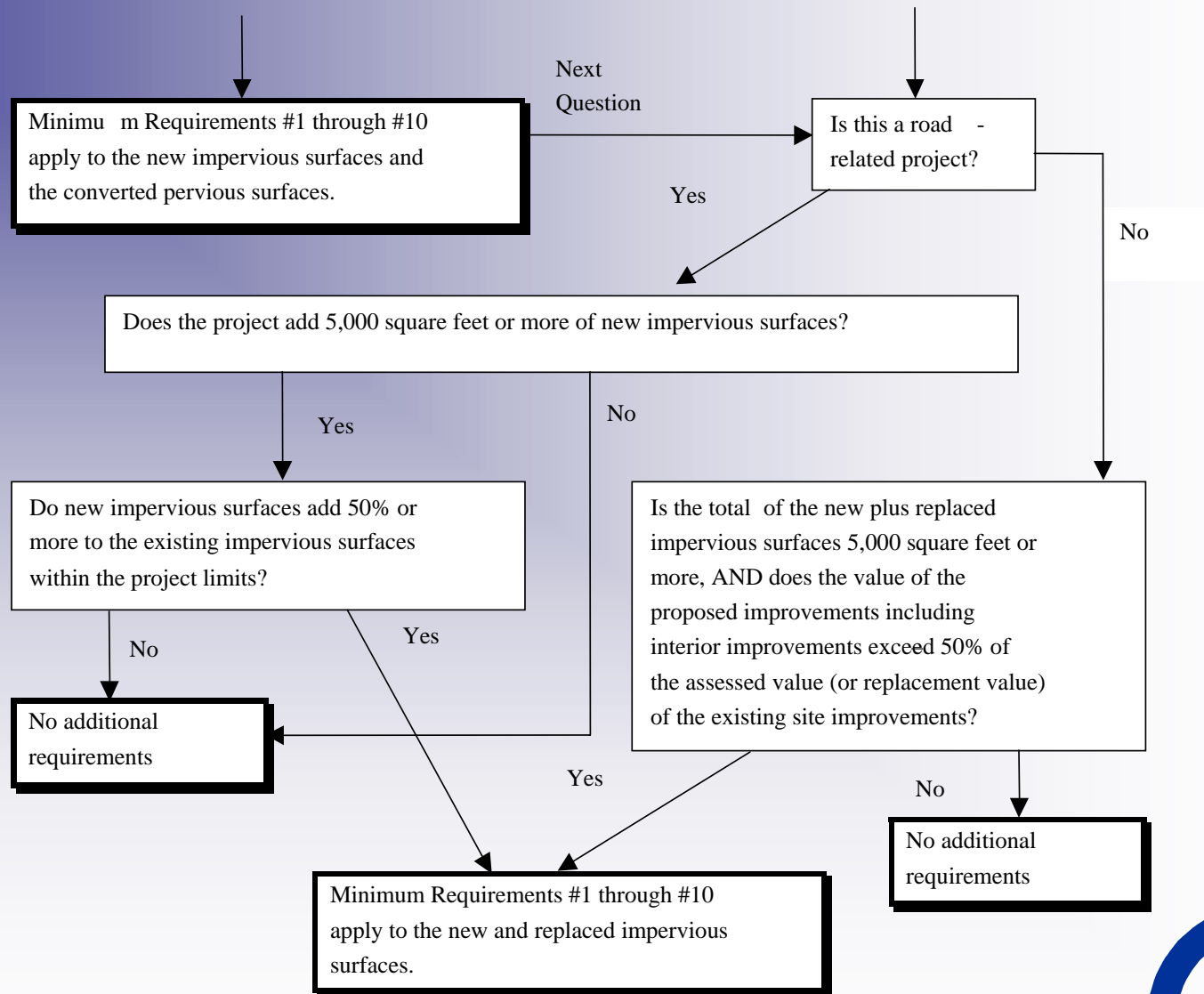
**Figure 2.2 Flow Chart for Determining Requirements for New Development**



**Figure 2.3 Flow Chart for Determining Requirements for Redevelopment**



**Figure 2.3 Flow Chart for Determining Requirements for Redevelopment**



# Wetlands Protection (MR #8)

- Section 2.5.8
- Meet standards **in addition** to treatment requirements in MR #6
- Not discharging to wetlands on this project



# Basin/Watershed Planning (MR #9)

- Section 2.5.9
- More stringent requirements may be placed on a project due to individual basin/watershed plans
- No special basin/watershed plan for this project



# Permanent Stormwater Control Plan (Chapter 4)

- I. Determine and read applicable minimum requirements
- II. Select Source Control BMPs
- III. Determine Threshold discharge areas
- IV. Select Flow Control BMPs and Facilities
- V. Select Treatment Facilities
- VI. Review selection of BMPs and Facilities
- VII. Complete Development of Permanent Stormwater Control Plan



# Step II. Select Source Control BMPs (MR #3)

- Commercial site requirement
- Vol. IV is dedicated to Source Control BMPs
- Designer concerned with structural BMPs, Operational are Owner/tenant
- Treatment overlap with Vol. V
- Operational and Structural Source Control BMPs (Section 2.2)
  - Fueling at Dedicated Stations (p. 2-19)
  - Maintenance and Repair of Vehicles and Equipment (p 2-34)
  - Parking and Storage Vehicles and Equipment (p 2-48)



# Step III. Determine Threshold Discharge Areas

- Thresholds on this project
- Total site area = 10 acres (435,600 sq ft)
- “New and Replaced” area = 5.2 acres
  - PGIS = 1.5 acres
  - Roof = 2.9 acres
  - Pond = .8 acres
- Remaining area (not controlled) = 4.8 acres
- 100 year flow increase 17.2 cfs
- Project requires treatment and flow control



# Step IV: Flow Control BMPs and Facilities

Minimum Requirement #5 (Section 2.5.5)



# Select Flow Control BMPs and Facilities

- Minimum Requirement #7 (Section 2.5.7)
- Match developed discharge durations to predevelopment durations for the range of discharge rates from 50% of the 2-year up to the full 50-year peak flow.



Name of Development: Commercial

Development Address: Stormwater Manual

City / County: Snohomish, Co.

### Project Description

WDM Time Series Data Type

Standard Residential

Non-standard / Commercial

### Predeveloped Acres

Outwash A/B 0

Till C/D 5.2

Saturated 0

Total Acres 5.2

### Predeveloped Vegetation

☒ Forest ☐ Pasture

### Basins

☒ Design Basin

☐ Bypass

☐ Offsite Inflow

### Pavement Credit

POROUS PAVEMENT

%

### Estimated Pond Area

A/B soils 0

C soils 0.8

### Nonstandard-Residential/Commercial

Impervious Area (Roof)

0

2.9

Landscaped Area

0

0

Streets/Sidewalks/Parking

0

1.5

Forest

0

0

Pasture

0

0

## Western Washington Hydrology Model

### Step 2

Fill in site information and list  
acres for each type of  
development.

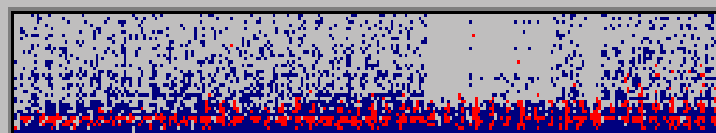
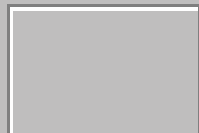
Ecology Manual Hydrology Standard  
(1):

Stormwater discharges to streams shall match developed discharge duration to predeveloped durations for the range of predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. In addition, the developed peak discharge rates shall not exceed the predeveloped peak discharge rates for 2- and 10- year return periods.

< Prev

Next >

### Flow Frequency Analysis For Predeveloped and Pre-pond Conditions



Progress (flow data)

Clear

#### Flow Frequency for Predeveloped Conditions

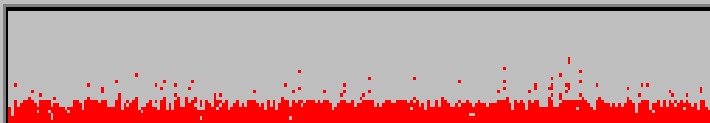
Return Period	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
(CFS)	0.345	0.483	0.58	0.709	0.81	0.915

#### Flow Frequency for Developed Conditions (Without Detention Facility)

Return Period	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
(CFS)	8.124	10.708	12.447	14.682	16.377	18.101

### Flow Frequency Analysis For Developed Area With Detention Facility

Perform



Progress (flow data)

Clear

#### Flow Frequency for Developed With Detention Facility

Return Period	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
(CFS)	0.323	0.413	0.465	0.523	0.562	0.598

View Duration Analysis

STOP

< Prev

Next >

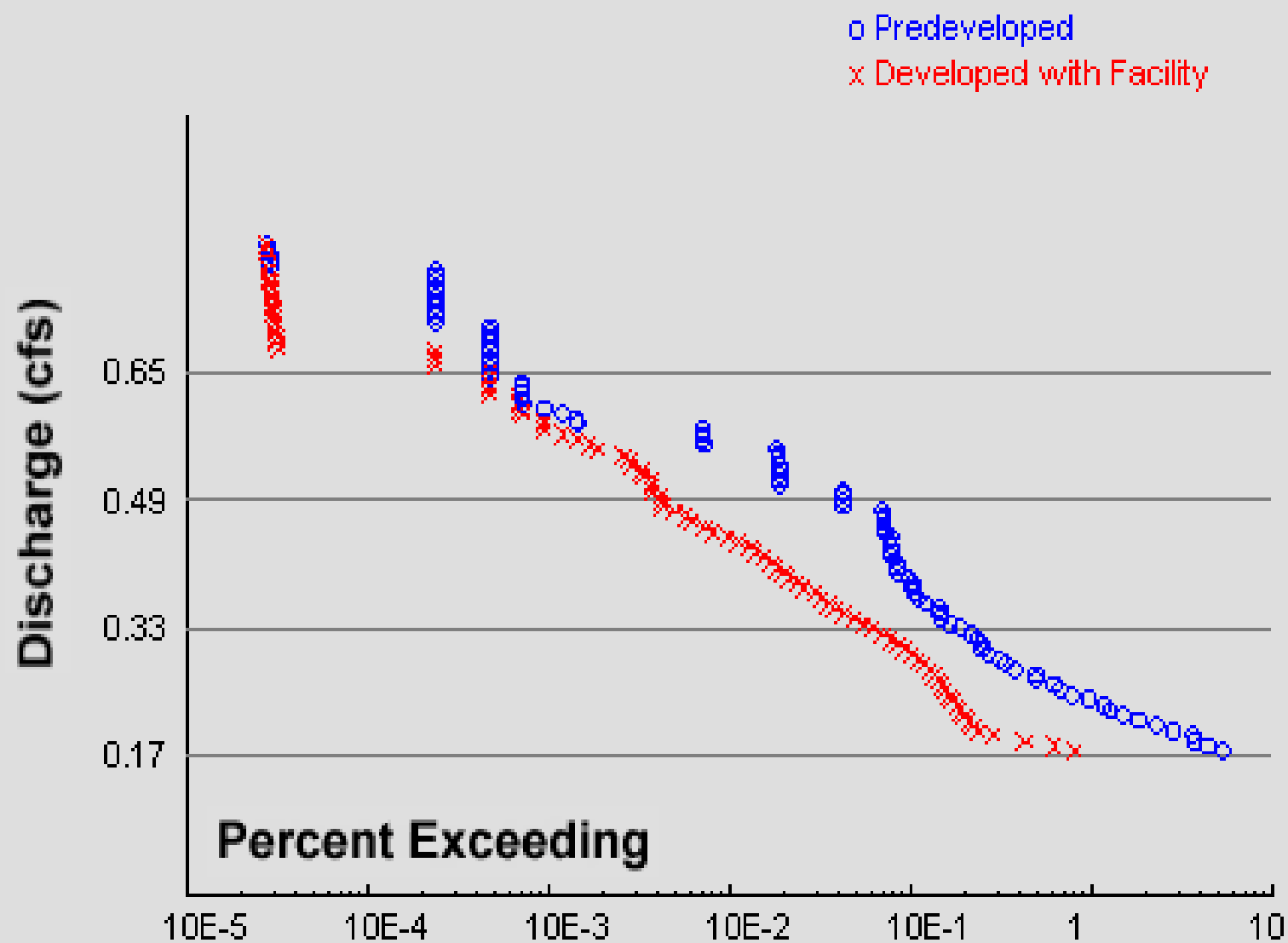
## Western Washington Hydrology Model

Step 7

Compare statistics.

Ecology Manual Hydrology Standard (1):

Stormwater discharges to streams shall match developed discharge duration to predeveloped durations for the range of predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. In addition, the developed peak discharge rates shall not exceed the predeveloped peak discharge rates for 2- and 10- year return periods.



Title

# Flow Control (cont.)

- Standard Detention pond (Vol. III, Section 3.2.1) 75' x 75', 6' deep
- Multiple orifice restrictor Control Structure (Vol. III, Section 3.2.4) 24" riser with 2.1", 2.65", and 2.75" openings at 0', 2.6, and 5.25' levels
- Used Ecology spreadsheet and WWHM to calculate
- 2-year, 24-hour discharge 0.323 cfs

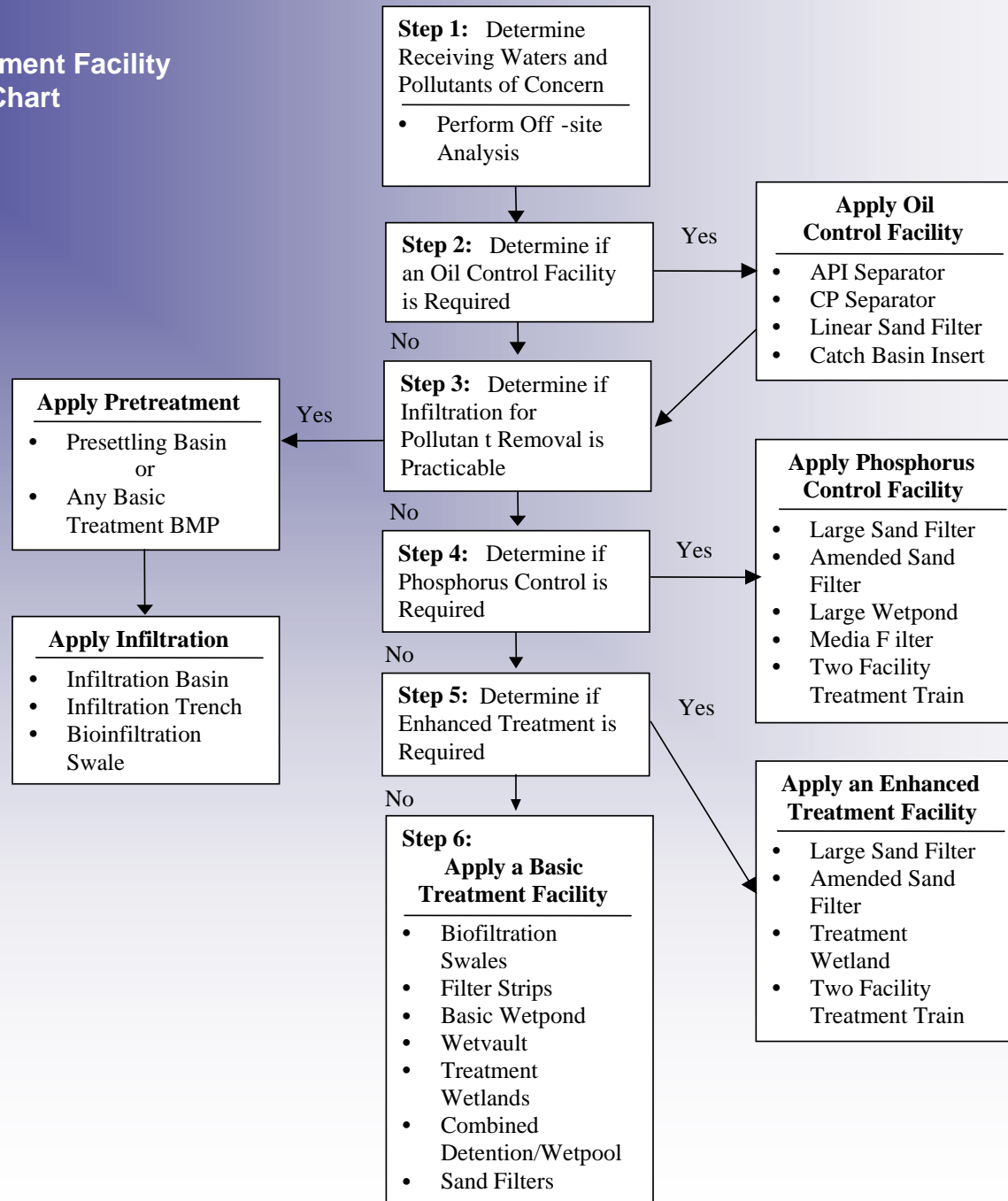


# Step V. Select Treatment Facilities

- Select treatment facility from Volume I, Chapter 4
- Insert Figure 4.1 of Volume I here



**Figure 4.1 Treatment Facility Selection Flow Chart**



# Enhanced Treatment

- See Vol. V, Section 3.4, Table 3.2
- Oil/Water Separator
- Two-Facility Treatment Train
  - Wet Vault
  - Sand Filter



# Oil/Water Separator Sizing

## Commercial Site Oil/Water Separator Sizing Calculations

(Calculations described in Vol. V, Chapter 11 BMP T11.10)

1.5 acres	Effective Impervious Surface
1.5 acres	Total Impervious Surface
100%	Ratio of effective to Total
0.43	Multiplication factor from Table 4.1, Vol. V
6.82 cfs	2-year return frequency for post developed site (from WWHM)
2.93 cfs	Design Flow rate (Factor times 2-year flow rate)

### Separator Bay Design

6.31 cfs	Design Flow rate times correction factor (2.15)
Calculate Forebay area	20 sq ft/10,000 sq ft of drainage area
6.53	Drainage Area/10,000 sq ft
130.68	Forebay area
13.07	Forebay length (area/assumed width)



# Oil/Water Separator Sizing

Calculate Separator size (API (Baffle type))

0.033 fps	Oil Rise Rate ( $V_t$ ) (assumed BMP T11.10)
<b>10 feet</b>	<b>Separator Width (assumed, 6 to 20 feet)</b>
0.4	Depth/width (assumed 0.3 to 0.5)
<b>4 feet</b>	<b>depth</b>
121.21 seconds	Minimum Residence time $t_m = d/v_t$
0.16	Horizontal velocity $V_h = Q/(d*w)$ (Max 2.0 fps)
4.78	$V_h/V_t$
1.66	F Vol. V, Table V-D
1.38	Turbulence and short-circuiting factor
31.72	Minimum Length of separator section $l(s) = F*(V_h/V_t)*d$
317 cu ft	Minimum hydraulic design volume $V = w * l(s)$
2,372 gallons	
<b>44.78 ft</b>	<b>total length</b>



# Wet Vault Sizing

## Commercial Site Wet Vault Sizing Calculations

(Vol. V, chapter 10 BMP T10.20)

Follow steps for sizing on page 10-5, Vol. V

2.5	2-year, 24-hour rainfall (in)
1.8	6-month, 24-hour rainfall (in) (72% of 2-year)
1.5	PGIS Area (acres)

### Calculation of Runoff volume from site

98.00	Weighted CN
0.20	$S = (1000/CN) - 10$ (Page 2-24, Vol III)
1.56	$Q_d \text{ (in)} = (P - 0.25 * S)^2 / (P + 0.8 * S)$ (Page 2-24, Vol III) (Average depth of runoff over site)
0.19	Volume of Runoff (ac-ft)
8,484	Volume of Runoff (cu ft)
	Vault volume (equal to Design Storm runoff volume)
40	Width of Vault (ft) (assumed)
3	Depth of Water (ft) (assumed)
70.70	Length (ft)



# Sand Filter Sizing

## Commercial Site Sand Filter Sizing Calculations

(Vol. V, Section 8.6 and BMP T8.10)

0.323      Design Flow rate (cfs) Based on the full 2-year, 24-hour rate from the PGIS area  
Calculated in WWHM (Vol. I, page 2-27)

Calculation of Sand Filter surface area (sq ft)

$$Q_s = K \cdot I \cdot A_{sf} \quad \text{where } i = (h+L)/L$$

$$A_{sf} = Q_{sf} / K \cdot i \quad \text{from Page 8-15 Vol V}$$

2 K (ft/day) Hydraulic conductivity (given by Ecology)

0.323  $Q_{sf}$  (cu ft/sec)

27,907  $Q_{sf}$  (cu ft/day)

1 h (ft) water depth above top of filter

1.5 L (ft) sand bed depth (given by Ecology)

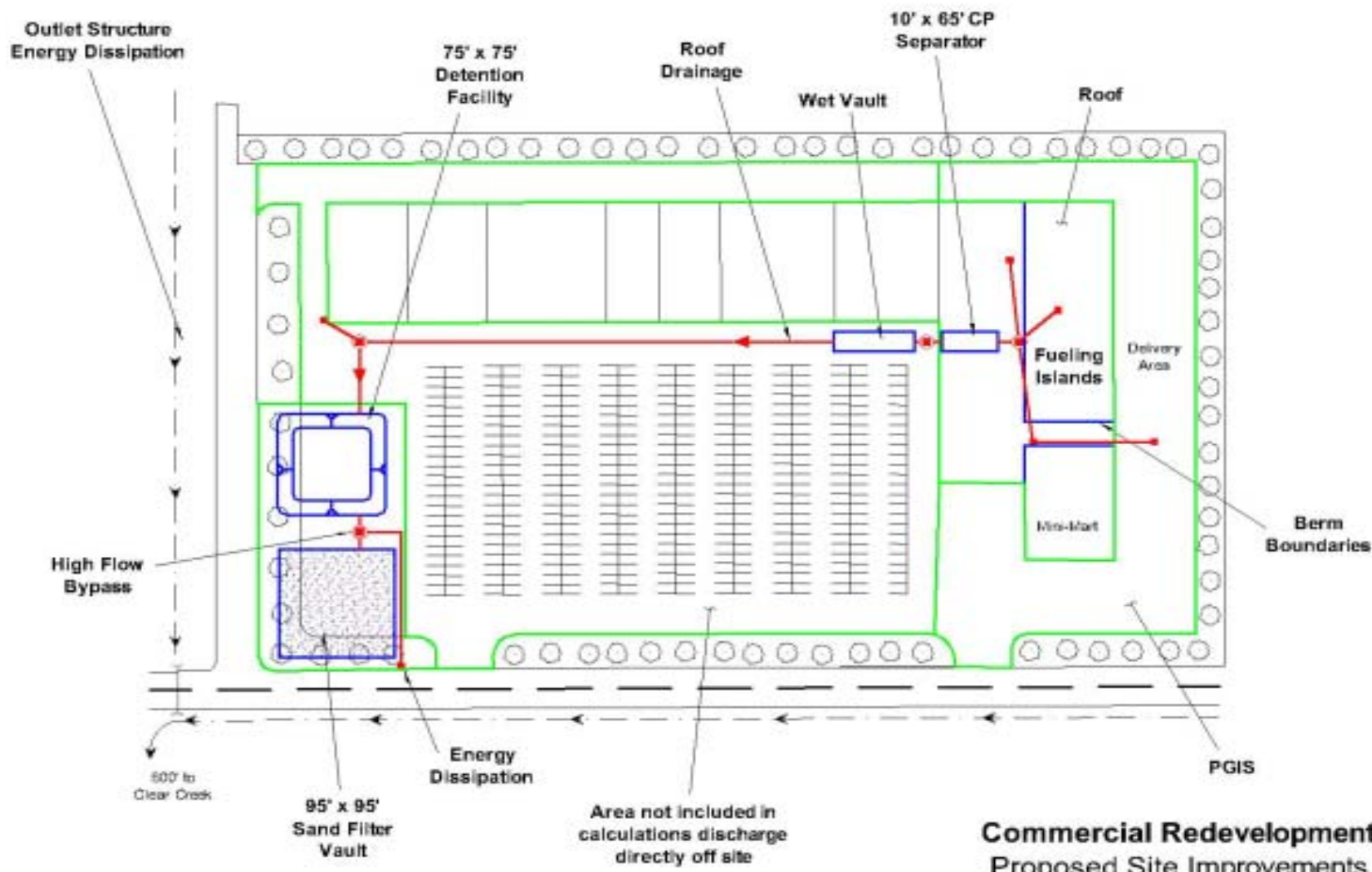
1.67 i (ft/ft) hydraulic gradient of pond

3.67 F (ft/day) Filtration rate =  $K \cdot i$

7,611.05 sq ft       $A_{sf}$  based on  $A_{sf} = Q_{sf} / K \cdot i$

87.24 ft      length of side for square sand filter      70





## Commercial Redevelopment Proposed Site Improvements



# Step VI. Review selection of BMPs and Facilities and Step VII. Complete Development of Permanent Stormwater Control Plan

- Prepare operations and maintenance manual for treatment and flow control facilities
- Chapter 4, Vol. V has guidance



# *Prepare SSP (Revisited)*

- 1 Collect and Analyze Information on Existing Conditions*
- 2 Prepare Preliminary Development Layout*
- 3 Perform Off-site Analysis (at local governments option)*
- 4 Determine Applicable Minimum Requirements*
- 5 Prepare a Permanent Stormwater Control Plan*
- 6 Prepare a Construction Stormwater Pollution Prevention Plan (SWPPP)*
- 7 Complete the Stormwater Site Plan*
- 8 Check Compliance with all applicable Minimum Requirements*



Questions???

